

VERSION WITH MARKINGS TO SHOW CHANGES MADE

TITLE

MULTI-PART PLUNGER

CROSS REFERENCE APPLICATIONS

This application is a non-provisional application claiming the benefits of provisional application no. 60/456,667 filed March 18, 2003.

FIELD OF THE INVENTION

The present invention relates to an improved plunger lift apparatus for the lifting of formation liquids in a hydrocarbon well. More specifically the improved plunger consists of a two piece apparatus that operates to increase the well efficiency, insure positive mechanical connection during lift, and separate at the top of the well.

BACKGROUND OF THE INVENTION

A plunger lift is an apparatus that is used to increase the productivity of oil and gas wells. In the early stages of a well's life, liquid loading is usually not a problem. When rates are high, the well liquids are carried out of the tubing by the high velocity gas. As a well declines, a critical velocity is reached below which the heavier liquids

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do not make it to the surface and start to fall back to the bottom exerting back pressure on the formation, thus loading up the well. A plunger system is a method of unloading gas in high ratio oil wells without interrupting production. In operation, the plunger travels to the bottom of the well where the loading fluid is picked up by the plunger and is brought to the surface removing all liquids in the tubing. The plunger also keeps the tubing free of paraffin, salt or scale build-up. A plunger lift system works by cycling a well open and closed. During the open time a plunger interfaces between a liquid slug and gas. The gas below the plunger will push the plunger and liquid to the surface. This removal of the liquid from the tubing bore allows an additional volume of gas to flow from a producing well. A plunger lift requires sufficient gas presence within the well to be functional in driving the system. Oil wells making no gas are thus not plunger lift candidates.

As the flow rate and pressures decline in a well, lifting efficiency declines geometrically. Before long the well begins to "load up". This is a condition whereby the gas being produced by the formation can no longer carry the liquid being produced to the surface. There are two reasons this occurs. First, as liquid comes in contact with the wall of the production string of tubing, friction occurs. The

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1 velocity of the liquid is slowed and some of the liquid  
2 adheres to the tubing wall, creating a film of liquid on the  
3 tubing wall. This liquid does not reach the surface.  
4 Secondly, as the flow velocity continues to slow the gas  
5 phase can no longer support liquid in either slug form or  
6 droplet form. This liquid, along with the liquid film on the  
7 sides of the tubing, begins to fall back to the bottom of the  
8 well. In a very aggravated situation there will be liquid in  
9 the bottom of the well with only a small amount of gas being  
10 produced at the surface. The produced gas must bubble  
11 through the liquid at the bottom of the well and then flow  
12 to the surface. Because of the low velocity very little  
13 liquid, if any, is carried to the surface by the gas. Thus,  
14 as explained previously, a plunger lift will act to remove  
15 the accumulated liquid.

16 A typical installation plunger lift system **100** can be  
17 seen in Fig. 1. Lubricator assembly **10** is one of the most  
18 important components of plunger system **100**. Lubricator  
19 assembly **10** includes cap **1**, integral top bumper spring **2**,  
20 striking pad **3**, and extracting rod **4**. Extracting rod **4** may  
21 or may not be employed depending on the plunger type. Below  
22 lubricator **10** is plunger auto catching device **5** and plunger  
23 sensing device **6**. Sensing device **6** sends a signal to surface  
24 controller **15** upon united plunger mechanism (UPM) **200**  
25 arrival at the well top. UPM **200** is shown to represent the

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plunger of the present invention and will be described below in more detail. Sensing the plunger is used as a programming input to achieve the desired well production, flow times and wellhead operating pressures. Master valve 7 should be sized correctly for the tubing 9 and UPM 200. An incorrectly sized master valve will not allow UPM 200 to pass. Master valve 7 should incorporate a full bore opening equal to the tubing 9 size. An oversized valve will allow gas to bypass the plunger causing it to stall in the valve. If the plunger is to be used in a well with relatively high formation pressures, care must be taken to balance tubing 9 size with the casing 8 size. The bottom of a well is typically equipped with a seating nipple/tubing stop 12. Spring standing valve/bottom hole bumper assembly 11 is located near the tubing bottom. The bumper spring is located above the standing valve and can be manufactured as an integral part of the standing valve or as a separate component of the plunger system.

Surface control equipment usually consists of motor valve(s) 14, sensors 6, pressure recorders 16, etc., and an electronic controller 15 which opens and closes the well at the surface. Well flow 'F' proceeds downstream when surface controller 15 opens well head flow valves. Controllers operate on time, or pressure, to open or close the surface

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1 valves based on operator-determined requirements for  
2 production. Modern electronic controllers incorporate  
3 features that are user friendly, easy to program, addressing  
4 the shortcomings of mechanical controllers and early  
5 electronic controllers. Additional features include: battery  
6 life extension through solar panel recharging, computer  
7 memory program retention in the event of battery failure and  
8 built-in lightning protection. For complex operating  
9 conditions, controllers can be purchased that have multiple  
10 valve capability to fully automate the production process.

11 Modern plungers are designed with various sidewall  
12 geometries and can be generally described as follows:

13 A. Shifting ring plungers for continuous contact  
14 against the tubing to produce an effective  
15 seal with wiping action to ensure that all  
16 scale, salt or paraffin is removed from the  
17 tubing wall. Some designs have by-pass valves  
18 to permit fluid to flow through during the  
19 return trip to the bumper spring with the by-  
20 pass shutting when the plunger reaches the  
21 bottom. The by-pass feature optimizes plunger  
22 travel time in high liquid wells.

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1           B.           Pad plungers with spring-loaded interlocking  
2                       pads in one or more sections. The pads expand  
3                       and contract to compensate for any  
4                       irregularities in the tubing thus creating a  
5                       tight friction seal. Pad plungers can also  
6                       have a by-pass valve as described above.

7           C.           Brush plungers incorporate a spiral-wound,  
8                       flexible nylon brush section to create a seal  
9                       and allow the plunger to travel despite the  
10                      presence of sand, coal fines, tubing  
11                      irregularities, etc. By-pass valves may also  
12                      be incorporated.

13          D.           Solid plungers with solid sidewall rings for  
14                       durability. Solid sidewall rings can be made  
15                       of various materials such as steel, poly  
16                       materials, Teflon, stainless steel, etc. Once  
17                       again, by-pass valves can be incorporated.

18          E.           Snake plungers, which are flexible for coiled  
19                       tubing and directional holes, and can be used  
20                       as well in straight standard tubing.

21           Recent practices toward slim-hole wells that utilize  
22   coiled tubing lend also themselves to plunger systems.

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1 Because of the small tubing diameters, a relatively small  
2 amount of liquid may cause a well to load-up or a relatively  
3 small amount of paraffin may plug the tubing.

4 Plungers use the volume of gas stored in the casing and  
5 the formation during the shut-in time to push the liquid  
6 load and plunger to surface when the motor valve opens the  
7 well to the sales line or to the atmosphere. To operate a  
8 plunger installation, only the pressure and gas volume in  
9 the tubing/casing annulus is usually considered as the  
10 source of energy for bringing the liquid load and plunger to  
11 surface.

12 The major forces acting on the cross-sectional area of  
13 the bottom of the plunger are:

- 14 • The pressure of the gas in the casing pushes up on the  
15 liquid load and the plunger;
- 16 • The sales line operating pressure and atmospheric  
17 pressure push down on the plunger;
- 18 • The weight of the liquid and the plunger pushes down on  
19 the plunger;

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- Once the plunger begins moving to the surface, friction between the tubing and the liquid load acts to oppose the plunger;
- In addition, friction between the gas and tubing acts to slow the expansion of the gas.

The major disadvantage of conventional plunger lifts is that the well must be shut-in in order for the plunger to fall to the bottom of the well. Two part plunger systems (ball-type or other non-positive mechanical plungers) can lose plunger piece to piece contact during lift due a drop in critical velocity, collar banging, hitting slugs of fluid, paraffin or scale particles, which decreases well efficiency. If the ball falls back to the bottom, fluid is then allowed to fall back to the bottom, which keeps the well in a loaded state. The only thing that holds the ball on the plunger is the upward flow of gas and fluid. See U.S. Patent Nos. 6,209,637 and 6,467,544 to Wells. When the Wells two-part piston rises, changing well conditions can cause the ball to disconnect from the sleeve, resulting in lost well production.

The present invention in its various embodiments latches a lower plug to an upper sleeve, thereby preventing an accidental separation. Plunger drop travel time slows or



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1 limits well production. Also fishing balls out of a well is  
2 a problem and sometimes requires pulling the complete tubing  
3 string. Well production increases are always critical. What  
4 is needed is a plunger lift apparatus that can insure a  
5 positive contact during lift, drop back to the well bottom  
6 quickly and easily and assist in increasing well production  
7 by increasing lift cycle times. What is also needed is a  
8 two-part plunger system that is retrievable from the well.  
9 The apparatus of the present invention provides a solution  
10 to these aforementioned deficiencies.

### SUMMARY OF THE INVENTION

11  
12  
13  
14  
15  
16 The main aspect of the present invention is to provide  
17 a two part plunger apparatus that will increase well  
18 production levels.

19 Another aspect of the present invention is to provide a  
20 two part plunger apparatus that ensures a mechanical  
21 connection during the lift from the well bottom and that  
22 will mechanically separate at the lift top.

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1 Another aspect of the present invention is to allow  
2 both the plunger top mechanism (PTM) and the plunger bottom  
3 mechanism (PBM) to independently fall inside the tubing to  
4 the well hole bottom with increased speed without impeding  
5 well production.

6 Another aspect of the present invention is to allow for  
7 current plunger sidewall geometries to be utilized in the  
8 PTM.

9 Yet another aspect of the present invention is to  
10 provide for a magnetic latching of the PTM and PBM during  
11 lift, the preferred embodiment.

12 Another aspect of the present invention is to provide  
13 for a mechanical latching of the PTM and PBM during lift, an  
14 alternate embodiment.

15 Yet another aspect of the present design is to provide  
16 a design that has an inherent flow by-pass when falling,  
17 thus eliminating any need for a by-pass valve.

18 Other aspects of this invention will appear from the  
19 following description and appended claims, reference being  
20 made to the accompanying drawings forming a part of this  
21 specification wherein like reference characters designate  
22 corresponding parts in the several views.

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1           The present invention comprises a plunger lift  
2   consisting of two separate parts that will latch together at  
3   the well bottom thus creating a united plunger mechanism  
4   (UPM) acting to carry fluids from the bottom of the well to  
5   the surface. The latching is a magnetic latching in the  
6   preferred embodiment. The latching can also be a mechanical  
7   latching in alternate embodiments. The UPM latching is  
8   deactivated at the top of the well by a rod or other de-  
9   latching device, thereby separating the UPM into the PTM and  
10   PBM. The PTM is auto-caught and held in the lubricator at  
11   the top surface while the PBM is allowed to separately fall  
12   back into the well.

13           The PTM will be dropped back into the well when well  
14   conditions are met with liquid loading. The PTM will re-  
15   latch to the PBM when it returns to the well bottom to form a  
16   solid two-piece plunger, the UPM.

17           The preferred embodiment of the present invention  
18   employs a fairly strong permanent magnet, which is encased  
19   within the PBM to provide a magnetic attachment to the PTM.  
20   Other embodiments of the present invention employ a  
21   mechanical latch between the PTM and PBM during lift.

22           The PBM is designed to have a smaller outside diameter  
23   (OD) than the tubing and a geometric design to allow it to

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1 quickly travel to the well bottom without impeding well  
2 flow. The PTM is designed with standard aforementioned  
3 sidewall geometries and a hollow inside to allow it to  
4 quickly travel to the well bottom once it is released by the  
5 auto-catcher at the surface.

6       The present invention assures an efficient lift due to  
7 the fact that both the PTM and PBM are latched to form one  
8 plunger unit during lift. The present invention also  
9 optimizes well efficiency due to the fact that both PTM and  
10 PBM can separately and quickly travel to the well bottom.

11

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**BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 (prior art) is an overview depiction of a typical plunger lift system installation.

Fig. 2 is a side view of the preferred embodiment of a UPM, separated into its PTM and PBM units.

Fig. 2A is a cross-sectional view of the PBM unit at point A-A of Fig. 2.

Fig. 3 is a side cross sectional view of the preferred embodiment of the present invention showing the UPM, shown in its magnetically latched state.

Figs. 4A, 4B ~~is~~ are blow-up cross-sectional views of the preferred embodiment of the present invention showing each subassembly of the UPM.

Fig. 5 is a side view of the PTM having solid ring side-wall geometry.

Fig. 6 is a side view of various prior art side-wall geometries ~~of the PTM~~.

Fig. 7 is a side view of the UPM with magnetic latching, the preferred embodiment of the present invention.

Fig. 8 is a side view of latch-down pickup, an alternate embodiment of the present invention.

Fig. 8A is a blow up of the latch-down pickup area of a compression ring pickup shown in Fig. 8.

Fig. 9 is a side view of a compression ring pickup, yet another alternate embodiment of the present invention.

Fig. 9A is a blow up of the compression ring pickup area as shown in Fig. 9.

Fig. 10 is a side view of a spring-loaded pickup, still another alternate embodiment of the present invention.

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25 Fig. 10A is a blow up of the spring-loaded pickup area as  
26 shown in Fig. 10.

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1 Fig. 11 is a horizontal cross-sectional view of Fig. 2,  
2 taken along line A-A, viewed in the direction taken  
3 by the arrows.

4 Fig. 12 is a horizontal cross-sectional view of Fig. 5,  
5 taken along line B-B, viewed in the direction taken  
6 by the arrows.

7 Fig. 13 is a side view of a spring-loaded top sleeve with a  
8 partial cutaway having a ball as the sealing  
9 plunger.

10 Fig. 14 is a side view of a compression ring top sleeve  
11 with a partial cutaway having a ball as the sealing  
12 plunger.

13 Fig. 15 is a side view of a latch down top sleeve with a  
14 partial cutaway having a ball as the sealing  
15 plunger.

16 Fig. 16 is a side view with a partial cutaway showing  
17 magnets in the top sleeve, and having a ball as the  
18 sealing plunger, the ball being made of a ferrous  
19 material such as stainless steel.

1 Before explaining the disclosed embodiments of the  
2 present invention in detail, it is to be understood that the  
3 invention is not limited in its application to the details  
4 of the particular arrangements shown, since the invention is  
5 capable of other embodiments. Also, the terminology used

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6    herein is for the purpose of description and not of  
7    limitation.  
8



1 | ~~invention is not limited in its application to the details~~  
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3 | ~~is capable of other embodiments. Also, the terminology~~  
4 | ~~used herein is for the purpose of description and not of~~  
5 | ~~limitation.~~

#### 7 | Detailed Description of the ~~Invention~~ Drawings

8 |  
9 | The present invention provides a plunger lift apparatus  
10 | that consists of two basic parts, a PTM and a PBM that are  
11 | latched together to form the UPM during lift. The plunger  
12 | lift of the present invention basically consists of the  
13 | following discrete steps:

- 14 | 1. The two piece plunger, or UPM, is at the  
15 | bottom of a well in a mechanically latched  
16 | state (magnetic or mechanical) with liquid  
17 | loading on top of the plunger;
- 18 | 2. The well is open for flow at which time the  
19 | UPM rises to carry liquids out of the well  
20 | bore.
- 21 | 3. The UPM separates at the top of the well into  
22 | its basic components, the PTM and PBM, via a  
23 | de-latching rod (or other means) while the PTM

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1                   is secured in an auto-catcher and the PBM  
2                   starts down the well at an increased speed  
3                   against the well flow without effecting well  
4                   operating efficiency due to its cross-  
5                   sectional geometry, which will be described  
6                   below in more detail.

7           4.       The well flows for a set time or condition  
8                   controlled by the well-head controller.

9           5.       The auto-catcher releases the PTM after a set  
10                   time or condition.

11          6.       The PTM, with its hollowed center orifice,  
12                   falls against the well flow at a faster rate  
13                   than a standard plunger and latches to the PBM  
14                   at the well bottom. The orifice allows the PTM  
15                   to travel to the well bottom without impeding  
16                   well flow and also optimizes plunger travel  
17                   time in high liquid wells.

18          7.       The well plunger lift cycle starts again.

19           The PTM and PBM that are latched together to form a  
20   single UPM during lift and separate back into two discrete  
21   parts (PTM and PBM) once at the well surface. The UPM acts  
22   as a sealed device during lift that functions to carry  
23   fluids to the well surface. The latching of the PTM and PBM

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1 during lift is maintained via either magnetic or mechanical  
2 latching. The preferred embodiment of the present invention  
3 employs a magnetic latching design. It should be noted that  
4 mechanical latching could also be employed.

5       The utilization of magnetic (or mechanical) latching  
6 assures connection of the PTM and PBM during the UPM lift  
7 from the well bottom. The mechanical separation of the UPM  
8 into the PBM and PTM is accomplished by a rod or de-latch-  
9 ing device at the top of the well, usually contained within  
10 the lubricator. Older systems employing a ball and top plunger  
11 mechanism tend to separate during lift causing lift  
12 restarts.

13       The PBM is geometrically designed to have a fluid/gas  
14 dynamic type shape to allow it to quickly pass against the  
15 flow and to the well bottom. Such designs may include, but  
16 not be limited to, a torpedo shape, an anvil shape, etc. The  
17 PBM is designed with outside dimensions to be sufficiently  
18 smaller than the tubing inside diameter allowing it to  
19 efficiently fall against the flow of the well. The PBM  
20 design allows gas or liquids to continue to flow to the well  
21 surface after the lift is complete and the PBM is falling  
22 against the well flow. The PBM will return to the bottom  
23 with an efficient speed until it comes to rest on the bottom

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1 sitting or on a bumper spring. This aforementioned falling  
2 action of the PBM will allow the well to continue to flow  
3 and will not impact the well flow efficiency thereby  
4 allowing for higher well production levels. If the  
5 'difference' in cross-sectional area of the PBM and the  
6 inside cross-sectional area of well tubing is equal to or  
7 greater than the minimum cross-sectional area of any other  
8 flow point in the well, full well flow can continue without  
9 the PBM impeding maximum flow. Likewise, no well flow will  
10 be impeded by the PTM if the inner orifice cross-sectional  
11 area of the PTM is greater than or equal to the minimum  
12 cross-sectional area of any other flow point in the well.  
13 The time to fall of both the PBM and the PTM is shorter than  
14 prior art allowing a time-savings in lift cycles, thus  
15 adding to well efficiency. Older design, solid plungers,  
16 not only required well shut-off, but also could not be released  
17 to fall back to the well bottom until flow had stopped.

18 In the preferred embodiment of the present invention,  
19 the PBM contains a relatively strong internal magnet. The  
20 magnet is positioned in proximity below the top surface of  
21 the PBM with its North and South poles facing in an axial  
22 direction along the PBM. A non-magnetic material is placed  
23 around the peripheral surface of the magnet (between the

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magnet and the outside surface of the PBM) to optimize magnetic flux lines to flow between the magnet's north and south poles. The top surface of the PBM is designed with a magnetic material and is annular in shape with a slanted surface (cone type shaped) to optimize magnetic latching to similar but outside annular type surface on the PTM. It should be noted that other surface shapes could be employed. Although the PBM of the preferred embodiment might consist of separate parts; combinations of set pins, screw-type designs or other mechanisms can be used to secure all individual parts into a one-piece PBM to hold each of its components together.

When the UPM is lifted to the top of the well and separation occurs allowing the PBM to fall to the bottom, the PTM is caught and held at the top of the well by an auto catcher. The PTM is dropped back into the well when predetermined well conditions are met. The PTM will re-latch to the PBM when it returns to the well bottom to form a united two-piece plunger, the UPM. The PTM is designed with an inside hollow orifice which allows it to quickly fall back into the well, against the well flow, without impacting well production. The outside surface of the PTM can be designed with any of the aforementioned type geometries such as ring,

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1 pad, brush, solid or snake. The inside hollow orifice design  
2 permits an inherent flow by-pass when falling, thus  
3 eliminating any need for a separate by-pass valve.  
4 Elimination of by-pass valves as found in prior art plungers  
5 increases plunger reliability and also avoids extra  
6 maintenance associated with cleaning obstructed valve and/or  
7 passages. The bottom of the PTM is made of a ferromagnetic  
8 material to help produce the most strongly magnetic  
9 attraction in latching to the PBM. The shape of the bottom  
10 of the PTM is annular and with an inside conical opening at  
11 the orifice to accept the shape of the outside conical  
12 dimension of the PBM. When the PTM falls to the well bottom,  
13 it magnetically latches to the PBM. This magnetic latching  
14 assures continuous latching during lift. The shape of the  
15 top of the PTM can be designed such that it allows easy  
16 retrieval from the well bottom. An indented inside top  
17 collar would easily allow a ball and spring mechanism on a  
18 plunger retriever to fall inside the PTM orifice (under  
19 spring pressure) at its top position. The top collar of the  
20 PTM can be designed with a standard American Petroleum  
21 Institute (API) internal fishing neck. The spring loaded  
22 ball within the retriever and protruding outside its surface  
23 would thus fall within the API internal fishing neck at the

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1 top of the PTM orifice for a small distance to a point  
2 wherein the inside diameter of the PTN orifice would  
3 increase to allow the ball to spring outward. This condition  
4 would allow retrieving of the entire UPM as the UPM is in  
5 its latched state.

6 Alternate embodiments of the present invention can  
7 utilize a mechanical latching of the PTM and PBM during  
8 lift. Such embodiments might employ mechanical means such as  
9 ball and spring mechanisms on one device (PTM or PBM) to  
10 latch into a groove on the other device (PBM or PTM).

11 The present invention assures an efficient lift due to  
12 the fact that both the PTM and PBM are latched to form one  
13 plunger unit during lift. The present invention also  
14 optimizes well efficiency due to the fact that both PTM and  
15 PBM can separately and quickly travel to the well bottom.  
16 Preliminary data indicates productivity increases ranging  
17 from 120% to 200% depending on well parameters.

18 Referring now to the drawings, Fig. 2 is a side view  
19 of the preferred embodiment of UPM 200 separated into both  
20 the PTM 20 and PBM 21. PTM 20 is shown with a 'solid ring' 22  
21 sidewall geometry. As previously described, other sidewall  
22 geometries such as 'brush' , 'ring' , 'pad' etc. can be  
23 employed in PTM 20. PTM 20 is basically an annular apparatus

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1 with an inner orifice, which can be seen below in Figs. 3,  
2 4A. PBM **21** is shown with an anvil-type shape to optimize  
3 efficiency when dropping against the well flow, while  
4 allowing the well flow to continue. PBM **21** consists of the  
5 following components:

- 6 1. Liquid/gas by-pass bottom end **24** with a mandrel  
7 type section with main flute **23** in a triangular  
8 shape and outer flutes 17 as inverted triangular  
9 shaped areas (see Fig. 2A);
- 10 2. By-pass south connector **25**;
- 11 3. Magnet isolator ring **26**, which is made of non-  
12 magnetic (anti-ferromagnetic) material, and  
13 contains the magnet (not shown). Magnet isolator  
14 ring **26** can be seen externally as an annular ring  
15 around the area surrounding the internal PBM  
16 magnet; and
- 17 4. By-pass head **28**.

18 Fig. 2A is a cross-sectional view of the PBM **21** unit  
19 across point A-A of Fig. 2. The A-A cross-sectional area of  
20 the liquid/gas by-pass end **21** is shown as a mandrel type  
21 section with main flute **23** in a triangular shape and outer  
22 flutes **17** as inverted triangular shaped areas. It should be



1 noted that although a specific geometry is shown, other  
2 geometries can be easily designed (for example, anvil  
3 shaped, spear shaped or other) that would allow PBM **21** to  
4 easily fall against the well flow. A good design for PBM **21**  
5 can be obtained if the cross-sectional area for 'any' cross  
6 section cut across PBM **21** has an area such that the  
7 'difference' between the cross-sectional area of PBM **21** and  
8 the cross-sectional area of the inner diameter of tubing **8**  
9 (ref. Fig. 1) is greater than the 'minimum' cross-sectional  
10 area of any other flow point in the well. This will assure  
11 that PBM **21** does not impede the well flow. Likewise, the  
12 cross-sectional area of PTM orifice should be equal to or  
13 greater than the 'minimum' cross-sectional area of any other  
14 flow point in the well.

15 Fig. 3 is a side cross sectional view of the preferred  
16 embodiment of a UPM **200**, shown in its magnetically latched  
17 state with PTM **20** magnetically latched to PBM **21**. PBM **21** is  
18 magnetically drawn into the bottom orifice of PTM **20** when  
19 fully magnetically latched. PBM **21** is shown in the preferred  
20 embodiment consisting of a plurality of sub-assembly  
21 components. Liquid/gas flow by-pass end **24** is designed in  
22 mandrel-type geometry to assist PTM **20** to easily fall

1 against the well flow. Other geometries (i.e., anvil, spear,  
2 torpedo etc.) could also be employed. Other PBM 21  
3 subassembly parts consist of subassembly bypass south  
4 connector 25, magnet isolator ring 26 (anti-ferromagnetic  
5 material), magnet 27, and by-pass head 28. Surface S is the  
6 conical surface at which annular surfaces from PTM 20 and  
7 PBM 21 are held magnetically and acts as a seal during lift.  
8 Annular upper surface S3 provides a secondary seal. Magnet  
9 27 is of sufficient strength to pull PBM 21 up into the  
10 receiving PTM orifice 29. Magnetic flux lines M are shown  
11 which permeate both sections of PTM 20 and PBM 21. PTM 20 is  
12 shown with a solid ring 22 outer surface geometry. Inner cut  
13 | grooves 30 of this geometry allow sidewall debris to  
14 accumulate when PTM is rising or falling. Other outer  
15 surfaces can also be employed (ref. Fig. 6). The top of PTM  
16 20 is designed as an API internal fishing neck for easy  
17 retrieval by a standard API internal fishing neck retrieving  
18 pickup mechanism (not shown) to retrieve UPM 200 in its  
19 mechanically latched form.

20 | Figs. 4A, 4B ~~is-are~~ are blow up views of UPM 200 showing  
21 each subassembly of PBM 21. PTM 20 is shown with a solid  
22 | ring 22 outer surface geometry and containing inner grooves  
23 30.

1 Liquid/gas by-pass end **24** is fluid/gas dynamic in shape  
2 allowing it to cut through the well flow. Shapes other than  
3 that shown can also be employed. Bottom end threaded area **41**  
4 allows for mechanical threading connection to bypass south  
5 connector **25** lower threads **43**. Liquid/gas by-pass roll pin  
6 hole **40** and bypass south connector roll pin hole **42** are  
7 aligned for a pressed pin (not shown) positive retention  
8 mechanism between liquid/gas by-pass end **24** and bypass south  
9 connector **25**. A magnet insulator ring **26** is attached to  
10 bypass south connector **25** via screwing south connector  
11 | threads **44** and magnet insulator ring threads **46**. The  
12 magnet insulator ring 26, which is a non-magnetic element  
13 such as aluminum, serves to isolate the sides of the magnet,  
14 thereby radiating longitudinally the magnetic flux lines **M**  
15 | (see Fig. 3) to better couple ~~the~~ magnet 27 to ~~the~~ PTM **20**.  
16 Bypass south connector roll pin hole **45** and magnet  
17 insulator ring roll pin hole **47** are aligned for a pressed  
18 roll pin (not shown) positive retention to hold both sub-  
19 assemblies into position. Magnet **27** is permanently  
20 positioned and is shown such that its north pole **N** faces  
21 upward and its south pole **S** faces downward. It should be  
22 noted that magnet **27** could also be aligned in an opposite  
23 manner to that shown, that is,

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1 with its north pole **N** facing downward and its south pole **S**  
2 facing upward. Surface **S1** is aligned and extends to surface  
3 **S2** when both subassemblies are together. These form annular  
4 surface **S** (ref. Fig. 3) of PBM **21** at which point PTM **20** and  
5 PBM **21** are held together magnetically. By-pass head **28** mates  
6 to magnet insulator ring **26** via by-pass head threads **49** and  
7 magnet insulator threads **48**. Both units are mechanically held  
8 together by a roll pin (not shown) placed by aligning magnet  
9 insulator roll pin hole **47** with by-pass head roll pin hole  
10 **50**. Roll pins are inserted after alignment and retained via  
11 compression or spreading of roll pin end(s). It should be  
12 noted that alignment of all roll pin holes in PBM **21** could  
13 be accomplished by any of the following methods:

- 14 1. Threading all PBM parts together and then  
15 drilling a roll pin holes in appropriate  
16 locations.
- 17 2. Pre-drilling roll pin holes and aligning holes  
18 after PBM parts are threaded together.

19 It should also be noted that other means of connecting  
20 PBM parts can be accomplished via use of adhesives within  
21 the threads to hold parts together (i.e. no roll pins) or  
22 other fastening means.

1           Fig. 5 is a side view of PTM **20** with solid rings **22**  
2 | sidewall geometry for durability and containing inner grooves  
3 | **30**. Sidewall geometry can be made of various materials such  
4 | as steel, poly materials, Teflon, stainless steel, etc.  
5 | Cross-section B-B is described below in Fig. 12.

6           Fig. 6 is a side view of various side-wall geometries  
7 | of the PTM. All geometries described below have an internal  
8 | orifice as previously described in PTM **20**. All side-wall  
9 | geometries described below can be found in present  
10 | industrial offerings. These side-wall geometries are  
11 | described as follows:

- 12           A.     As previously discussed solid ring **22** sidewall  
13                   is shown in solid plunger PTM **20**. Solid  
14                   sidewall rings **22** can be made of various  
15                   materials such as steel, poly materials,  
16                   Teflon, stainless steel, etc.
- 17           B.     Shifting ring **81** sidewall geometry is shown in  
18                   shifting ring plunger top mechanism **80**.  
19                   Shifting rings **81** sidewall geometry allows for  
20                   continuous contact against the tubing to  
21                   produce an effective seal with wiping action to  
22                   ensure that all scale, salt or paraffin is

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1 removed from the tubing wall. Shifting rings  
2 **81** are all individually separated at each  
3 upper surface and lower surface by air gap **82**.  
4 C. Pad plunger top mechanism **60** has spring-loaded  
5 interlocking pads **61** in one or more sections.  
6 Interlocking pads **61** expand and contract to  
7 compensate for any irregularities in the  
8 tubing thus creating a tight friction seal.  
9 D. Brush plunger top mechanism **70** incorporates a  
10 spiral-wound, flexible nylon brush **71** surface  
11 to create a seal and allow the plunger to  
12 travel despite the presence of sand, coal  
13 fines, tubing irregularities, etc.

14 Fig. 7 is a side view of the UPM **200** with magnetic  
15 latching, the preferred embodiment of the present invention.  
16 Shown are aforementioned PTM **20** and PBM **21**. It is shown  
17 again for reference purposes alongside alternate  
18 embodiments.

19 Fig. 8 is a side view of latch-down pickup **300**, an  
20 alternate embodiment of the present invention. In this  
21 alternate embodiment, latch down top mechanism **310** is  
22 mechanically latched to latch down bottom mechanism **302**.

Fig. 8A is a blow up of the latch-down pickup area 303. At the bottom of latch down top mechanism 310 is a set of two or more female pickup fingers 304, which wrap around recessed male sleeve 305. Recessed male sleeve 305 is tapered down from upper neck 306 providing a recess for female pickup fingers 304 to compress around recessed male sleeve 305. Female pickup fingers 304 (two or more) will expand in direction 307 as shown when upper neck 306 enters latch down top mechanism 310 and contract when over tapered down recessed male sleeve 305. Surface mating area 83 provides for a seal upon plunger lift. An orifice in latch down top mechanism 310 is similar to PTM orifice 29 as previously described. As aforementioned extracting rod 4 (ref. Fig. 1) separates latch down top mechanism 310 from latch down bottom mechanism 302 upon lift completion at the well top.

Fig. 9 is a side view of a-compression ring pickup 400. In this alternate embodiment, compression ring top mechanism 410 is mechanically latched to compression ring bottom mechanism 402. Fig. 9A is a blow up of the-compression ring pickup area 403. At the bottom of compression ring top mechanism 410 is recessed groove annular ring 404, which allows compression ring 405 to expand, thereby allowing compression ring top mechanism 410 to mechanically latch to compression ring bottom mechanism 402. Compression ring 405

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is affixed to compression ring bottom mechanism **402** and will compress as compression ring bottom mechanism **402** enters compression ring top mechanism **410**. Compression ring **405** can be made with various compressible materials such as, but not limited to, rubber, nylon, steel, or other metallic or poly-type materials. Surface mating area **S3** provides for a seal upon plunger lift. An orifice in compression ring top mechanism **410** is similar to PTM orifice **29** as previously described. As aforementioned extracting rod **4** (ref. Fig. 1) separates compression ring top mechanism **410** from compression ring bottom mechanism **402** upon lift completion at the well top.

Fig. 10 is a side view of a spring-loaded pickup **500**, still another alternate embodiment of the present invention. In this alternate embodiment, spring-loaded top mechanism **510** is mechanically latched to spring-loaded bottom mechanism **502**. Fig. 10A is a blow up of the spring-loaded pickup area **503** as shown in Fig. 10. At the bottom of spring-loaded top mechanism **510** is a recessed area containing spring **504** and ball **505**, which sit in slot hole **507**. Ball **505** will contract into spring **504** when spring-loaded bottom mechanism **502** enters spring-loaded top mechanism **510**. Spring-loaded bottom mechanism **502** contains recessed annular groove (bearing race) **506** which will allow ball **505** to expand out from spring **504** and maintain a



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mechanical connection between units a spring-loaded bottom mechanism **502** enters into spring-loaded top mechanism **501**. Surface mating area **S3** provides for a seal upon plunger lift. An orifice in spring-loaded top mechanism **501** is similar to PTM orifice **29** as previously described. As aforementioned extracting rod **4** (ref. Fig. 1) separates spring-loaded top mechanism **501** from spring-loaded bottom mechanism **502** upon lift completion at the well top.

It should be noted that other types of mechanical pickup mechanisms could be designed to insure a 'positive' mechanical contact during plunger lift.

Fig. 11 is a horizontal cross-sectional view of Fig. 2, taken along line A-A, viewed in the direction taken by the arrows. Shown is PBM **21** inside of inner diameter **ID** of well tubing **9**. If area **A2** is equal to or greater than the minimum cross-sectional area of any other flow point in the well, full well flow can continue without the PBM impeding maximum flow. PBM **21** has many different cross-sectional areas, and although only one area is shown, if the 'difference' in any cross-sectional area of the PBM and the inside cross-sectional area of well tubing is equal to or greater than the minimum cross-sectional area of any other flow point in the well, full well flow can continue without the PBM impeding maximum flow.

Fig. 12 is a horizontal cross-sectional view of Fig. 5, taken along line B-B, viewed in the direction taken by the arrows. PTM 20 is shown inside inner diameter ID of tubing 9. A very small gap G between the outside of PTM 20 and inside diameter ID of tubing 9 allows PTM 20 to travel down tubing 9 to the well bottom where it will attach to PBM 21. In this case the inside cross-sectional area A1 of orifice 29 should be equal to or greater than the 'minimum' cross-sectional area of any other flow point in the well in order to optimize well flow.

Referring next to FIG. 13 ~~the~~ spring-loaded top mechanism 510 is shown in cutaway view and described in FIG. 10. However, a ball B serves as the sealing plunger, also called the bottom mechanism.

Referring next to FIG. 14 ~~the~~ compression ring top mechanism 1410 has an O-ring shown in cutaway view, also called a compression ring 1411 in a groove 1411 of the lower arm 1412. This embodiment functions similar to the FIG. 9 embodiment using a ball B as the bottom mechanism.

Referring next to FIG. 15 ~~the~~ latch down top mechanism 310 is shown in cutaway view and described in FIG. 8. However, a ball B serves as the bottom mechanism.

Referring next to FIG. 16 the top mechanism, also called ~~the~~ sleeve 1600 has its lower segment 1601 shown in cutaway view to display magnets M which attract ball B. Ball B serves as the bottom mechanism as in FIGS. 13. 14, 15.

1           Although the present invention has been described with  
2   reference to various embodiments, numerous modifications  
3   and variations can be made and still the result will come  
4   within the scope of the invention. No limitation with  
5   respect to the specific embodiments disclosed herein is  
6   intended or should be inferred.